Structure of Security Elements for Documents and Apparatus for Examining Documents Provided with Such Security Elements as well as Method of Using such Security Elements and Apparatus.

The invention relates to the structure of security elements for documents and apparatus for examining documents provided with such security elements as well as a method of using these security elements and apparatus.

Hitherto, documents provided with optically effective diffraction security elements are examined by complex optical examining technology. It is not possible to examine documents provided with optically effective diffraction security elements or with so-called OVD's (optically variable devices) in a document processing machine because of its high processing speed. For instance, U.S. patent 4,255,652 describes an apparatus for detecting characterizing indicia in documents provided with electrically conductive areas. A charge is transmitted to one of the electrically conductive areas by means of a first capacitive element extending across the width of, and arranged above, the document to be examined. During further transport of the document to be examined, the charged electrically conductive area moves below a second capacitive element extending across the width of the document to be examined. The charge is dissipated by the second element and an evaluation and decoding circuit generates a typical signal function.

The apparatus and the operational principle applied are based upon relatively large electrically conductive areas which extend over the width of the document to be examined, for the size of the transported charge diminishes strongly in smaller surfaces. A simultaneous examination of several areas is as impossible as it is to define their geometric shape and size, particularly in designs of delicate members.

Furthermore, European patent EP 0,097,570 proposes an apparatus for examining the dielectric properties of sheet-like materials in which the

material to be examined is moved through contact pairs of an array of capacitors of predetermined configuration. A change in the dielectric properties causes a change in the voltage at the receiving electrodes. The signals are individually amplified and evaluated.

In this apparatus which is based upon examining the dielectric properties of the sheet material, more particularly of water marks, all capacitors are simultaneously energized by the frequency of an oscillator which may lead to a coupling between adjacent channels. If one chooses a larger distance between the capacitors in order to avoid this defect, the attainable geometric resolution is reduced. Hence, coarse structures only can be detected. To control the problem of transient oscillations at the receiving electrodes of the capacitors only a relatively low switching frequency is permissible which limits the speed at which the examinations can be carried out. For structural reasons, too, such an apparatus cannot be used in high speed processing machines.

German patent DE 27 47 156 describes a method and a testing device for examining the genuineness of identity cards secured by holograms. The OVD is reproduced and is thereafter subjected to a visual control. This method is not suited for a high-speed, efficient examination independent of a person.

European patent EP 0,042,946 describes an apparatus for generating scanning patterns which are examined by a laser, mirror and lens system as well as by a photodetector. In this case, too, the economic complexity is very high. It would increase even further where the material to be examined were to be examined without prior sorting. In order to avoid pre-sorting either a multiple arrangement of the system for examining the genuineness or repeated examinations would be necessary.

European patent EP 0,092,691 A1 describes an apparatus for detecting security strips in banknotes. The material-specific absorption bands of a plastic security strip are measured by means of two penetrating light channels operating in the infrared range at wavelengths of about 5 mm. An examination of the genuineness and quality of optically effective diffraction

security elements has neither been described in the mentioned European patent, nor would it be possible with the described apparatus.

A light reflection examination of banknotes by means of a line scan camera is known from British patent GB 21 60 644 A, and from Swiss patent CH 652,355 it is known to examine cards of a specific layer structure by reflective or penetrating light. In both cases, the examination is one in which image data are compared with originals. The reflections and traces of use which occur in the two methods are problematic and, hence, a great disadvantage.

German laid-open patent specification 38 11 905 describes an automatic examination for the genuineness of holographic data. For examining a hologram by penetrating light, the arrangement described in the laid-open specification provides for disposing transmitter and receiver directly opposite each other in order to be able to analyze the data of the hologram. Because of direct exposure to light in the intervals between consecutive banknotes, this opposite arrangement of transmitter and receiver leads to overriding which is disadvantageous in terms of the measuring operation and in certain circumstances to damage of the receiving elements. When examining used banknotes, creases therein render an examination practically impossible because of random reflections.

In accordance with the known methods described *supra* it is necessary precisely to position the objects to be examined, and all of the apparatus are unsuitable for high speed processing machines.

German patent specification 196 04 856 A1 proposes to carry out the examination of optical security characteristics of such metallically reflective layers as kinegrams, holograms and the like on securities, in particular banknotes, for their condition, quality or acceptability such that a metallically reflective safety element of the document is scanned in a manner known per se by penetrating light by at least one electronic camera, preferably a CCD line scanning camera and to compare the actual values thus detected against desired values by known image evaluation processes in order to mark banknotes with defective safety characteristics or to separate defective

banknote in a sorting apparatus. As described in German patent specification DE 196 04 856 A1, the apparatus is characterized by a transport device known per se for moving the securities in the range of the electronic camera, an infrared radiation source at that side of the security to be examined which faces away from the camera and by the fact that the optical axis of the camera and the optical axis of the illumination device enclose an angle deviating from 180°, and that the transport device is preferably made up of transport belts which are separated from each other transversely to the transport direction. This apparatus or method also suffers from the disadvantage that especially used banknotes with creases, or banknotes with a kinegram foil which is damaged or the surface of which is soiled, will not be recognized as genuine banknotes. Moreover, while the described method and the related apparatus are automated they are unsuitable for the high speed banknote machines in today's market which have a through-put of 1,200 pieces per minute.

At present, optically effective diffraction security characteristics or OVD's on such securities as, for instance, German 100 and 200 mark banknotes are manually or visually examined for damage, acceptability, precise formation of their margin, and so forth. The examination is carried out visually during production of the banknotes as well as when it may be necessary to separate circulating banknotes. These methods are time-consuming and expensive. Moreover, the examination is not accurate since in the case of optically effective diffraction security elements their demetallized zones have so far been fabricated by chemical etching processes. As is well known, such processes do not permit an exact contour of the desired structures. As a rule, "frayed" contours result. As is known from U.S. patents 5,248,544 as well as 5,388,862 optically variable security elements for documents such as so-called holograms or safety threads are provided with layers of metal layers for reflection in holograms. Optically effective diffraction security elements or OVD's are used only to achieve optical effects and may be examined only by optical test methods or by visual inspection. Other methods of examination, especially for high speed

processing machines, are not known.

In German patent specification 195 42 995 A1 there is described, among others, a method of examining the genuineness of a data support by adjustment of the various available data. In accordance with this patent the following possibilities exist:

- Comparing the standard image of the hologram with the image of the memory unit;
- Comparing the data of the hologram with the data in a defined area of the data support and/or those in a memory;
- Comparing the date of the hologram with those data which are available from an input unit;
- Comparing the individual image of the hologram with data from the input unit, the memory and/or the data of the defined area.

This method, too, is time-consuming and expensive. Optically, the examination is performed by balancing by way of image recognition by means of a reading device, and, therefore, it is unsuited for high speed processing or examination machines.

The various characteristics to be examined, examination zones and structures as well as the examination methods and apparatus for testing the genuineness of objects, securities, especially banknotes, suffer from the major disadvantage which is inherent in the fact that they are known. That is to say, they are known to an extent which make it possible for a counterfeiter on the basis of the examination methods and apparatus and their function to draw conclusions in respect of the characteristics to be examined, the examination zones and structures. From this, it is necessary to derive a completely new definition of a task in respect of the examination of objects, securities , especially banknotes, the accomplishment of which must be precipitated in a novel method of utilizing the examination characteristics, examination methods and apparatus in order to prevent data codes from being discovered and copied.

The task of the invention resides in eliminating the disadvantages of

the prior art and, especially, to complete the structure of security elements for documents with further security elements and to propose apparatus for examining such security elements and a novel method of using security elements and apparatus which make it substantially more complicated, if not impossible, from the functioning of examination methods and apparatus to make conclusions in respect of the security elements in order to produce counterfeits so similar to their originals that they cannot be detected by the examining apparatus.

A further task of the invention is to propose optically effective diffraction security elements and characteristics or OVD's which may be accurately examined quickly, independently of personal assistance and with little effort. The related apparatus for examining security characteristics are to be used in high speed document processing machines as well as in hand-held examination devices. Furthermore is it a task of the invention to fashion a plurality of the devices in accordance with the invention in such a manner that they examine a defined number of several security elements or characteristics provided on a document with the number of security elements differing between the devices. The purpose of this task is to provide different examination techniques in keeping with the possible expense and the security elements which can be examined.

The task is accomplished by the following description of the invention.

The structure of security elements with a metallic reflection layer for documents to be examined does not aim, *prima facie*, at visual inspection but at a design aiming at a method of examination. This design - hereinafter referred to as functional design - is the combination of electrically conductive and insulated structures of identical or differing size in identical or different planes with identical or differing conductivities and is fabricated from metallized structures and/or conductive inks or printing dyes. In its variegation and different constitutions, the functional design contains coding functions in all distinguishable security elements and, hence, is capable of

encrypted examination. In accordance with the invention the functional design may be an optically effective diffraction security element, or it may consist of conductive dyes or inks. Structured as an optically effective diffraction element, it may conform to the optically, i.e. visually perceptible design, or it may even assist it in its optical design.

Structures of metallizations and electrically conductive dyes and inks such as lines, dots and figures which may be examined by capacitive coupling are labeled security element. Such security elements are arranged on documents singly or in combinations.

A security characteristic consists of at least one security element and preferably of a compilation of identical or differing arrangements, size, hues and/or conductivity.

Optically effective diffraction security elements are fabricated from metallized structures rather than demetallization of individual structures as heretofore, by using known fabrication technologies. In order to fabricate the security elements to be examined in high quality, metallized security elements are fabricated in accordance with the invention with a very high approximation of the desired metallic structure and steep edges to adjacent insulating structures. The steepness of these edges makes it possible to fabricate and examine micro-structures. As has already been mentioned *supra*, the demetallized zones of optically effective diffraction security elements have hitherto been fabricated by chemical etching processes. As is known, such processes do not make it possible to make steep edges and exact contours of desired structures. As a rule, "frayed" marginal contours are created. Such marginal contours do not permit the use as functional design of demetallizations of widths in the range of a tenth of a millimeter. To obtain exact marginal contours for a functional design, it is necessary to apply a different fabrication technology. A target-oriented metallization with adjacent non-metallized zones is carried out in known super vacuum vaporizing equipment. For counterfeiters, these means an increased expense for the production of counterfeits. Aside from known more or less full-surface areas,

the optically effective diffraction security elements are provided in their examination zones with at least one security element shaped as beams, grids, bows and/or circles of a line width ≤ 5 mm. At the same time, these security elements constitute an encryption of data which are recognized and evaluated by means of the apparatus in accordance with the invention.

The apparatus for examining the security elements in accordance with the invention is provided with a capacitively operating scanner. This scanner consists of a plurality of transmitting electrodes disposed adjacent each other in one or more rows and a receiving electrode disposed parallel to the array.

Compared to sensors with large-surface electrodes, the scanner with insignificant electrode surfaces offers the advantage of resulting lower capacitive coupling between individual electrodes. In a document processing machine, the scanner is arranged so that optical or mechanical sensors present in common document processing machines activate the examining device of the present invention. To reduce errors of detection and measurement, a sensor support is preferably utilized which mounts all sensors necessary for the examination. The spacings between sensors are minimized. Minimizing the spacings between the sensors is necessary for reducing the change in position of the documents to be examined, since during movement of the document its position changes as a result of its condition, the degree of wear of the machine as well as ambient conditions, especially temperature and humidity. The distance between document changes as a result of imprecise insertion of the documents. An oblique movement of documents may be the result of worn transport rollers and bearings, implying that a document just inserted will rotate during transport. This undesirable change in position leads to interference with a defined time sequence which, in turn, causes false rejections. The smaller the security elements the more problematic is their detection. The apparatus in accordance with the invention is provided with a biasing device which constitutes a very small resistance for the document. This biasing device guides the document in parallel relative to the transmitting and receiving electrodes or preferably biases the document against the scanner.

Furthermore, the shafts of the transport rollers are connected to a mass by means of sliding contacts. The additional screens and the biasing device ensure repeatable examination conditions including a uniform distance or contact between documents, and the functionality of the sensor is improved. Activation of individual transmitting electrodes by electrical energy takes place sequentially by an electronic energizing circuit of a switching frequency in the kHz range and above. Aside from a current source, the main components of the electronic energizing circuit are a multiplexer, an oscillator for providing energy for the transmitting electrodes and an oscillator for energizing the multiplexer.

In the presence of electrical conductivity the energy of any energized transmitting electrode is capacitively coupled to the receiving electrode. The signal pattern at the receiving electrode is converted into a corresponding signal image. The signal image depends upon the metallized structure of the optically effective diffraction security element. An electronic evaluation circuit at the output of the receiving electrode compares the signal image of the test document to appropriate reference signals. The electronic evaluation circuit in essence consists of a current source, an amplifier, a demodulator, a comparator, a micro-processor with a memory and filters for the suppression of extraneous and interference signals.

In addition to the software for the micro-processor there are stored in the memory reference signal images which in dependency of the security elements to be examined are compared to the scanned signal image of the test document. Since the scanner exceeds the entire width of the document every electrically conductive security element will be detected by the apparatus in accordance with the invention. The comparison with the reference signal images delivers a classifying signal for further processing. Accordingly, a document identify as counterfeit, for instance, could be sorted out by stopping the test device or by diverting the transport path of the document. In order to reduce interferences the sensor support is connected in a compact manner with a board which supports the electronic energizing and evaluation circuits. As a variant, it is within the scope of the invention to

arrange an elongate transmitting electrode in parallel to a array of a plurality receiving electrodes arranged in side by side relationship. In such a case, the receives signals are processed by a multiplexer. The additional electronic evaluation circuit corresponds to the one already described.

A further embodiment of the transmitting and receiving electrodes is characterized by the fact that a plurality of transmitting and receiving electrodes are arranged in side by side relationship and/or in a row. Energization as well as reception of the signals are processed by multiplexing and demultiplexing processes.

When used in manual devices, they will be analogously equipped with corresponding devices for transporting the document or the scanner and which are functionally similar to those of copy machines, optical image insertion scanners or telecopying machines. As a variant thereto, a device is provided which defines the position of capacitively operating scanners of the examining apparatus in accordance with the invention by means of abutments.

For the target-oriented examination of a defined number of security elements of a document the apparatus is provided with a differing number of transmitting and receiving electrodes disposed in a side by side arrangement. The greater the resolution attained thereby, the more security elements and encryptions of a heightened degree of difficulty as regards counterfeiting may be examined. In this manner it is possible to manufacture simple manual devices, for instance for every-day use, in a simple, easily usable and cost-efficiently, by means of which the presence of security elements, for instance a simple safety thread, is examined. This is realized by a simple micro-processor software which is sensitized to certain security characteristics only and which is not public. An increased resolution with correspondingly structured software for the micro-controller makes it possible to examine all security characteristics. Such high examination complexity is used, for instance, by manufacturers of such security characteristics and by users of high security standards to yield the highest possible test results. In this

manner, different conductivities may also be recognized.

In accordance with the invention, it is within the scope of the invention to execute an image recognition and an examination of the document condition within the total system of the use of the described security elements and apparatus for the examination of documents. An image recognition is possible by way through coding by means of the electrically conductive security elements. The coding may be an automatic one or one which assists as an auxiliary means for sorting, a coding relating to the definition of nominations and a coding for defining the genuineness. In an automatic coding no further security element will be present, and the electrically conductive security element must be unambiguously identifiable by, for instance, its position on the document, so that the rate of erroneous rejections is reduced. In the case of an assisting auxiliary coding further characteristics are present; the coding then serves as a reference in case an erroneous rejection has been recognized. A condition control is performed by means of the examining apparatus in accordance with the invention in that the conductivity of a security element permits conclusions in respect of the condition of a document, because, empirically, a badly worn document results in a deterioration of its electrically conductive structures and, therefore, a change in its electrical conductivity. The individual degrees of wear are classified by means of software. Hence, documents of a predetermined degree of wear can be sorted out. This degree of wear is evidenced, for instance, by a partially damaged OVD, a torn document and a security element thus damaged reduced or an excessively crumpled document which may have caused a fracture within the security element. Hence, many-faceted possibilities of combinations result between examination for authenticity, image recognition and control of condition. Aside from an optical structuring of security characteristics on a document to be examined -as described above- the security elements in accordance with the invention will be provided with codes which are mathematically related -for instance for forming a sum- and which result in a main code which together with a signal or code from a simultaneously conducted examination for the genuineness of

a metallic safety strip and/or from a further simultaneously performed examination of the OVD determines the genuineness, the condition or the series of a predetermined document.

The characteristics of the invention are apparent not only from the claims but also from the specification and drawings, with individual characteristics constituting advantageous and patentable embodiments, either by themselves or, as sub-combinations, in connection with other embodiments, for which protection is sought hereby. Embodiments of the invention are depicted in the drawings and will be described in greater detail hereinafter.

In the drawings:

Fig. 1 is a schematic presentation of a document with a meandering metallized security characteristic;

Fig. 2, 3 are schematic presentations of a document with a strip-shaped metallized security characteristics;

Fig. 4 is a schematic presentation of a document with a grid-shaped metallized security characteristic;

Fig. 5 is a schematic presentation of a document with several security characteristics;

Fig. 6 is a block circuit diagram of an examining apparatus;

Fig. 7 - 9 are schematic presentations of different scanners;

Fig. 10 is a schematic presentation in side elevation of the scanner and a document to be examined;

Fig. 11 is a schematic section of metallized security elements;

Fig. 12 is a voltage - time diagram of the evaluation signal related to Fig. 11; and

Fig. 13 - 15 are schematic presentations of scanners and a structured security characteristic.

Each of the examples shown in Fig. 1 to 5 shows a document with security elements in accordance with the invention, which contain a target-

oriented electric code. The code is not formed by encrypting any kind of data, but, rather, by the arrangement of electrically conductive structures relative to each other or in one another and separated by non-conductive structures, electrically conductive examination indicia are arranged in a target-oriented manner the electrical decoding of which by the examination apparatus of the invention results in a predetermined signal pattern which is compared to an already present stored signal pattern. This yields the desired high examining speed. [see description Fig. 14].

The capacitively operating scanner of the apparatus in accordance with the invention has also been schematically shown.

Fig. 1 depicts the schematic structure of a security element 1 with metallized layers 2. The metallized layers 2 are separated by an insulating zone 3. In top elevation, the insulating zone is shaped like a meander. The width of the insulating zone 3 shaped like a meander is larger than the smallest distance between two electrodes. The capacitively operating scanner 4 consists of a plurality of transmitting electrodes disposed in side by side relationship and a receiving antenna 6 disposed in parallel to this array. Fig. 2 depicts the schematic structure of a security element 1, in which strip-shaped metallized zones 7 and insulating strip-shaped zones 8 are alternatingly arranged in parallel relationship. The zones 7, 8 which in top elevation are strip-shaped extend either parallel to, or vertically of, the direction of document transport. The latter case is depicted in Fig. 3. The distance between two zones of the same conductivity is between .2 mm and 1.0 mm. The widths of the zones of the same conductivity are varying. Zones of different conductivity and different widths are also possible.

Fig. 4 represents a combination of the characteristics of Fig. 2 and 3. Strip-shaped metallized zones 7 and insulating strip-shaped zones 8 are alternatingly arranged in parallel to the direction of document transport. The metallized zones 7 are interrupted by a strip-like insulating zone 9 extending vertically thereof.

Fig. 5 depicts a document with several security characteristics. The deliberate combination results in a further coding. This leads to increased

examination safety.

Fig. 6 to 9 present a block circuit diagram as well as different embodiments of the capacitively operating scanner 4.

Fig. 5 is a block circuit diagram of the examining apparatus in accordance with the invention, consisting of an electronic energizing circuit, a capacitively operating scanner 4 and an electronic evaluation circuit. The electronic energizing circuit essentially consists, in addition to a current source, of a demultiplexer 10, an oscillator 11 for providing energy for the transmitting electrodes and an oscillator 12 for energizing the demultiplexer.

The electronic evaluation circuit consists essentially of a current source, an amplifier 13, a demodulator 14, a comparator 15, a microprocessor 16 with a memory as well as filters for the suppression of extraneous and interference signals.

The transmitting and receiving electrodes are cast into a sensor support. They for a capacitively operating scanner 4 across the entire width of the document fee path. The strip-shaped receiving electrode extends normal to the document fee path. The transmitting electrodes are arranged in parallel to the receiving electrode. The distance between a transmission electrode and the receiving electrode is determined by the electrically conductive security elements typical of a document. Aligning several transmitting electrode in a row results in the possibility along the longitudinal axis of the capacitively operating scanner 4 simultaneously to detect several electrically conductive characteristics. The resolution attainable in this arrangement depends upon the number of transmitting electrodes used. in the present embodiment the resolution at a scanable point per mm extends in the longitudinal as well as the transverse direction. The minimum distance between adjacent transmitting electrodes is limited by the interfering capacitive coupling among them. In order top prevent this and to reduce the interference of adjacent transmitting electrodes, the transmitting electrodes are energized sequentially by a multiplexer 10. Arranging the transmitting electrodes across the entire document feed path results in the documents being examined regardless of their disposition. Accordingly, there is no need

for pre-sorting several documents in a document processing machine.

Fig. 7 is a schematic presentation of the scanner 4 with a plurality of transmitting electrodes 5 and one receiving electrode 6. Energization and evaluation is carried out as in the block circuit diagram of Fig. 6.

Fig. 8 schematically presents an embodiment of the capacitively operating scanner 4 with one transmitting electrode 17 and a plurality of receiving electrodes 18. In contrast to the block circuit diagram of Fig. 6, the transmitting electrode 17 is energized by an oscillator. The signals at the receiving electrodes 18 are processed by means of a multiplexer. Additional electronic evaluation circuitry consisting of current source, an amplifier, a demodulator, a comparator, a micro-processor with a memory and filters for the suppression of extraneous and interference signals, is the same as in the block circuit diagram of Fig. 6.

Fig. 9 is a schematic presentation of a further embodiment of the capacitively operating scanner having a plurality of transmitting electrodes 19 and a plurality of receiving electrodes 20. They are alternatingly disposed in a row. Therefore, the energizing signals of the transmitting electrodes 19 as well as the evaluation signals at the receiving electrodes 20 are respectively processed by multiplexing and demultiplexing processes.

Fig. 10 is a schematic presentation in side elevation of the capacitively operating scanner 4 and a document to be examined. The security characteristic 1 contains metallized lines 21 as well as an electrically insulating support foil 22.

Fig. 11 is a schematic section through a security characteristic with a support layer 23 and a partially metallized layer 24. The partially metallized layer 24 contains several insulating segments 25. The partially metallized layer 26 is of an electrical conductivity different from the partially metallized layer 24. In the schematic presentation the edges of the partially metallized layers 24, 26 are depicted in an idealizing manner at a right angle to the surface of the support layer 23. Margins or edges of this kind cannot even approximatingly be fabricated by conventional chemical processes, such as etching, as they lead to "frayed" edges in the longitudinal direction as well as

angles varying between acute and obtuse with respect to the support layer 23. To obtain marked signal patterns the metallized layers 24, 26 must, by contrast, be provided with a steady longitudinal pattern and with edges which engage the support surface 23 at almost a right angle. Electro-chemical or electro-corrosive demetallizing processes are particularly suited for this purpose. The related evaluation signal is shown as a voltage - time diagram in Fig. 12.

Fig. 13 to 15 are schematic presentations of scanners 33, 34, 35 and a structured security characteristic 36. The structure of the security characteristic 36 consists of an annular metallized security element 37, a strip-like metallized security element 38 and two rectangularly metallized security elements 39, 40. The examination safety is attained through the noticeably high steepness of the edge of the metallizations, as it significantly increases the difficulties of forgery. Simple manual apparatus contain a scanner 33 in accordance with Fig. 13. The resolution is so low that the strip-like security element 38 only may be detected. Such manual apparatus are ideally suited for every day use, for they are simple, easily handled and producible in a cost-efficient manner.

Apparatus of higher resolution as in Fig. 14 contain a scanner 34 and in addition to the strip-like security elements, they permit examination of additional security elements such as, in this case, an annular security element 37. The rectangular security elements 39, 40 are not examined. This is accomplished by simple soft-ware technology sensitized to certain security elements only. The rectangular security elements 39, 40 are not stored in memory as reference signal images.

Fig. 15 depicts a higher resolution with correspondingly structured software for the micro-controller. It makes it possible to examine all security elements, i.e. even the rectangular security elements 39, 40. To maintain the brilliancy of the optically effective security elements the micro-structures are fabricated by target-oriented metallization. This result in steep edges relative to non-metallized structures.

To accomplish the task of the invention, i.e. to propose a novel method

for use of security elements and examination apparatus to counteract the awareness or the quick publicizing of the function of examination methods and apparatus, the following use of security elements will be explained in connection with the corresponding use of the method and apparatus in accordance with the invention.

Broad use of the invention requires the definition of groups of examiners to whom is imparted certain knowledge of an examination system and who perform, by means of prescribed examination technology, examination as regards authenticity, but also image recognition and an examination of the condition.

The use of the examination system will be explained on the basis of groups A, B and C.

Group A:

It is well-known that government banks publish security characteristics of banknotes to enable a user to perform an examination under a guideline. Such publications relate to methods of examination which are performed with aids and methods performed with aids. The scanning sensor is incorporated in a manual apparatus. A examination of the electrical conductivity is performed of certain security elements by this manual apparatus and special software.

The software is modified so as to activate the scanner when moving the banknote across optical scanners, and the run-through length is measured subsequently. The electrical conductivity of a security element must be present at a set value. The end of the banknote is determined by optical sensors and the scanning sensor is deactivated. In this manner, the position of an electrically conductive security element on the test object may established. The data are compared with stored date and evaluated by a controller.

Group B:

Group B posses machines for processing banknotes. These machines

are equipped with special sensors for detecting different characteristics. At present, such machines are equipped with sensors for the optical range and/or for detecting magnetic properties and/or for examining the run-through length by means of a capacitive sensor. With these sensors it is possible to detect the presence of electrically conductive characteristics larger than 6 mm. They do not permit detection of electrically conductive security elements in the run-through width. Also, detection of differing electrical conductivity in the security elements is not possible. Structures within a security element can also not be detected. However, the described examinations are possible with the scanner so that Group B may perform an examination of higher value.

The software in Group B is structured so as to activate the scanning sensor by the optical sensors and thereafter to recognize the annular metallized security characteristic 37 and the strip-like metallized security characteristic 38. The value of the conductivity is pre-set. Deviations above and below 30% are rejected.

Group C:

The software is structured so as to recognize all security elements. The scanning sensor is activated by means of optical sensors. Run-through length and run-through width of security characteristic 36, the annular metallized security element 37, the strip-like security element 38 and the rectangular security elements 39, 40 are recognized. The electrical conductivity is pre-set, and deviations above or below 30% are rejected.

The entire examination system may be varied in particular in Groups A and B, and in respect of examining the Euro its defined tasks may be nationally changed. Since the security characteristic to be examined in the Euro, for instance, is the same for all states, the method of examination as well as the examination apparatus may be modified and changed in a timed sequence for national purposes depending upon points of emphasis.

The use of the security elements and examination apparatus as described above, is applied as follows: An image recognition may take place

by means of encode target-oriented metallizations. The image recognition may be used for different purposes such as, in particular, purposes of sorting, defining nominations or genuineness. A further advantage of the method of examination resides in the control of the condition. Conclusions may be drawn as to the condition of banknote paper by measuring the electrical conductivity. Badly worn paper will strongly reduce the electric conductivity.

The structure of security elements and an apparatus for examining such elements has been described in the context of the present invention on the basis of concrete embodiments. It is to be noted, however, that the invention is not limited by details of embodiments described in the specification, as changes and alterations are claims within the scope of the claims. The deliberate combination of optically effective diffraction security elements with other electrically conductive means results in a further coding. At the same time, further electrically conductive characteristics such as, for example, an electrically conductive security thread, may be classified by the examination apparatus in accordance with the invention.